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RESEARCH ARTICLE

ASSESSING ANTHROPOGENIC PRESSURE ON LAND USE AND LAND COVER IN THE MAFERE SUB-PREFECTURE IN SOUTH-EAST CÔTE D'IVOIRE

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Abstract

Several hectares of forest disappear every year in Côte d'Ivoire, particularly in the Aboisso Department. Despite the fight to preserve biodiversity and forest cover, numerous pressures (anthropogenic pressures) continue to be exerted on the forests, leading to their destruction and even increased deforestation. This deforestation has many consequences, including reduced biodiversity and climate change. This study was initiated to gain a better understanding of this reduction in forest area. The aim of the study is to assess the level of forest degradation in the Maféré sub-prefecture. The activities involve mapping and analyzing the dynamics of land use and land cover (LULC). To achieve these objectives, the study is based on satellite images (Landsat 5, 7 and 8) from 1986, 2000 and 2020. The results of LULC dynamics show, on the one hand, a decline in closed forest/swamp forest (96.29%), degraded forest (76.75%), crop/fallow (67.03%) and annual crops (38.35%) and, on the other hand, an increase in cocoa (675.25%), oil palm (193.13%), rubber (14.39%) and housing/bare land (101.26%). The extension of agricultural areas in search of resources (natural and financial), demographic pressures, still traditional cultivation techniques and climate change are the main factors causing the degradation of forests in the Maféré sub-prefecture.

Introduction:-

Forests are ecosystems that cover almost 31% of the world's land area. More than a third (34%) of the world's forests are primary forests, i.e. naturally regenerated forests composed of native tree species [1]. These forests contain most of the Earth's biodiversity and play an important role in sequestering carbon and maintaining the planet's equilibrium ([2], [3]). They also provide water, mitigate the effects of climate change and provide a habitat for many pollinators, which are essential for sustainable food production.

Globally, around a billion people are dependent to some degree on food from wild fauna and flora, such as game, edible insects, edible plant products, mushrooms and fish, which are often rich in essential micronutrients. In addition to the abundance of edible products, around 2.6 billion people in urban and rural areas use wood energy for cooking and heating [4]. The growing needs of the world's population are putting great pressure on natural

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resources, threatening natural ecosystems and the lives that depend on them [5]. These pressures take the form of deforestation, overgrazing, overexploitation of fodder resources, wildfires and cultivation techniques. We are witnessing a decline in vegetation cover in general and tropical forests in particular.

This situation does not exclude the African continent, particularly tropical regions ([6], [7]) where annual deforestation has been estimated at 2.8 million hectares for the period 2010-2015 [8]. However, this area is of great importance for biodiversity conservation because of its high level of endemism in terms of both flora and fauna [9].

In Côte d'Ivoire, forest cover has declined considerably as a result of logging and the expansion of cultivated areas [10]. The development of crops such as cocoa, coffee, oil palm and rubber, and the exploitation of logs have led to the degradation of more than 83% of forest areas. This degradation of the forest environment and its biodiversity has affected all regions of Côte d'Ivoire, particularly the south-east and south-west, which in 1996 accounted for 91% of the country's forested areas ([11], [12]) From 16 million hectares at the end of the 19th century, the surface area of dense rainforest fell to just over 1 million hectares in the 2000s [12].

The sub-prefecture of Maféré, located in the Aboisso Department and the subject of this study, has lost most of its forest area to cash crops, especially oil palm and rubber [13]. Given the scale of this situation, the main concern is to assess the share of these crops in the deforestation process, to know the exact state of the remaining forest areas and also to analyze their impact on forest cover in the Aboisso department. To this end, several studies have decried the illegal exploitation of resources and/or changes in land use and land cover (LULC) in south-eastern Côte d'Ivoire ([14], [15], [13]), leading to unprecedented degradation of certain forest areas, despite their protected status. What is happening to the forest cover of the Maféré sub-prefecture, which is located in a fast-growing area?

To answer this question, the general objective of this study is to assess the level of forest degradation in the Maféré sub-prefecture using remote sensing. It is underpinned by the specific objectives of mapping LULC between 1986, 2000 and 2020, in order to monitor changes, and then analyzing the changes obtained.

Methods:-

Study area

The sub-prefecture of Maféré is located in the Sud-Comoé region between latitudes 5°41' and 5°24' North and longitudes 3°1' and 3°03' West. It is one of the 8 sub-prefectures of the Department of Aboisso. It is bordered to the north by the departments of Abengourou and Alépé, to the south by the departments of Tiapoum and Adiaké, to the west by Grand-Bassam and to the east by the Republic of Ghana (Figure 1). Like that of the region, the vegetation is made up of closed forests and hydromorphic formations. It is characterized by species such as Bassam mahogany (*Khayaivorensis*)[16]. This vegetation was opened up very early to plantation agriculture (oil palm, cocoa and rubber trees) and has been heavily anthropised (Figure 2). The strong presence of cash crops is therefore the consequence of the disappearance of forests, apart from a few pockets of protected areas ([17], [13]). The climate is equatorial, with abundant rainfall averaging around 1,500 mm over the last ten years[17]. There are 4 seasons, including two rainy seasons and two dry seasons. The soils belong to the groups of ferralitic soils that are heavily leached under heavy rainfall [18]. Although these soils are deep, their chemical quality is poor. The main river running through the department is the Bia. However, it is watered by several rivers, including tributaries of the Bia and the Tanoe[17].

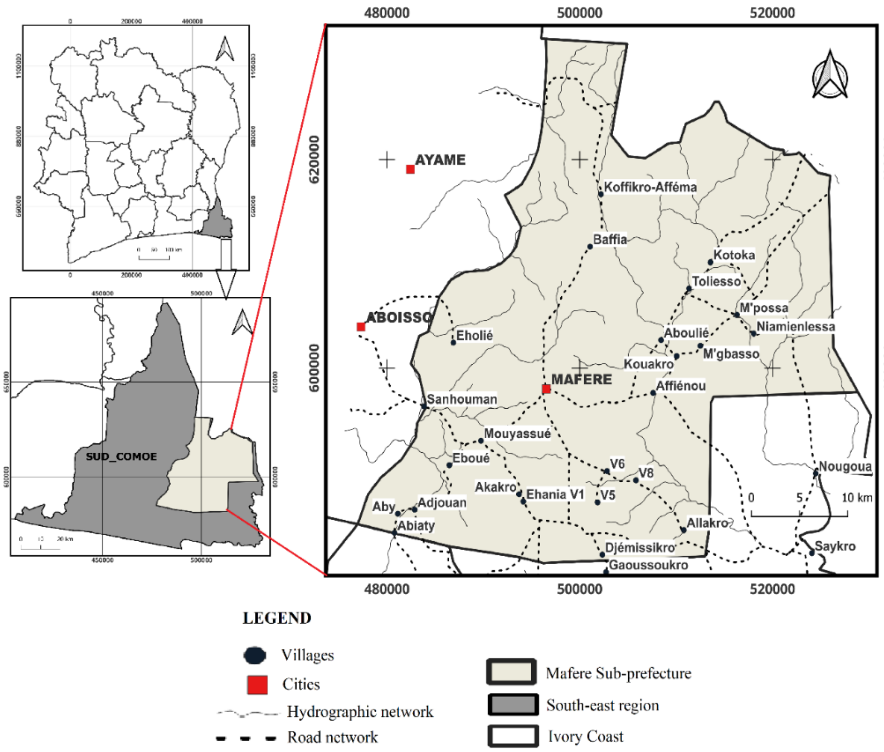

Figure 1:- Location of the study area (Maféré sub-prefecture).

A- Rubber trees

B- Oil palms

C- Cocoa

Figure 2:- Cash crops of the study area.

Satellite data and software

This study required the use of technical equipment, image data and software. The technical equipment consisted of a GPS (Global Positioning System), for recording the geographical coordinates of the control plots; a digital camera, for taking photographs in the field. Several software packages were used. These were ENVI 5.1 (Environment for Visualizing Images), for digital processing of satellite images; QGIS (Quantum Geographical Information Systems) and IDRISI TerrSet 2020, for GIS (Geographical Information Systems) applications and cartographic production.

Digital data processing

The methodology adopted in this work combined satellite image processing techniques and field observation techniques. In order to improve the appearance of objects in the satellite images and enhance their visual interpretation, the Landsat images were enhanced by contrast stretching (histogram equalization), after extraction from the study window, to increase the tonal distinction between the different elements in the scene. Visual interpretation is used to analyze the structures in the satellite image. This was carried out in two (2) essential stages, namely the calculation of the Normalized Difference Vegetation Index (NDVI) [19] and the Red/Green/Blue (1R, 2G, 3B) color composite using principal component analysis (PCA) [20]. The actual digital processing began with the production of undirected LULC classes to be used as a basis for the field visit missions. The NDVI was thus calculated:

$$NDVI = (TM4 - TM3) / (TM4 + TM3) \quad (1)$$

TM4 and TM3, is the near infrared and red channels respectively.

This index was used to characterize the different vegetation in terms of the intensity of their photosynthetic activity:

Color composite is used to display color images, taking into account the spectral signature of objects. It involves assigning fictitious colors to spectral bands in order to obtain better discrimination of LULC [21]. In this study, the 4R-5G-6B color composite was carried out for all images (Figure 3). This allowed us to identify the different thematic units through a diversity of coloring. These are natural formations (closed forest or swampy forests, degraded forests); cash crops (oil palms, cocoa, rubber trees); fallow land and crops; water reservoirs and dwellings and bare soil. The information gathered in the field was also used to finalize the digital processing.

Supervised classification of Landsat images using the neural network algorithm has made it possible to produce LULC maps. This algorithm performs a non-parametric classification (does not require the establishment of a statistical model of the classes), making it powerful [22]. The neural networks used were implemented in ENVI 5.1 using the Neural Net classification module. In this study, the parameters that were defined are the same as those of Jofack et al. [23], Douffi et al. [24] and N'Guessan et al. [25]. In its execution, a reasonable number of iterations were set to 1000; a momentum of 0.88, a stopping threshold of 0.15, a learning rate set to 0.03, a sigmoid transfer function and a single hidden layer were chosen to obtain the LULC maps using ENVI 5.1 software. 350 LULC points were converted into polygons by digitization on Landsat OLI false-color composite using bands shortwave visible Green (B4), visible red (B5) and near-infrared (B6) in the corresponding red, green and blue (RGB) color channels or RGB (4,5,6).

The accuracy of the maps was assessed by comparing the classified image with the field data. This comparison is based on the confusion matrix, which indicates the similarities and differences between the data. The confusion matrix was calculated for each of the classified images, because it allows us to check the quality of the training and gives an estimate of the validity of the classification [26].

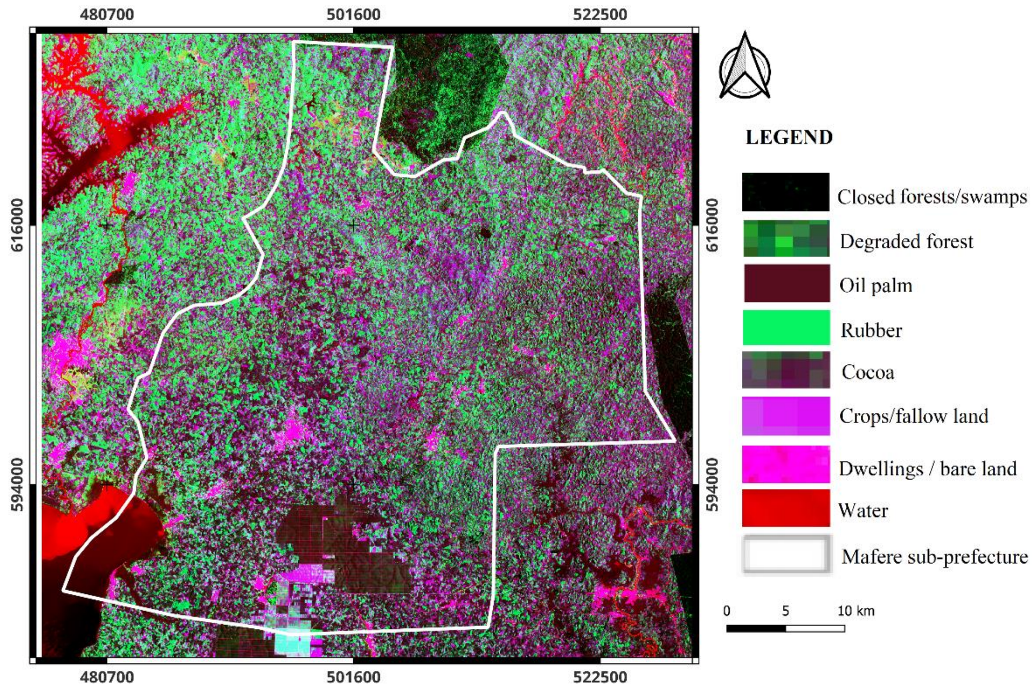

Figure 3:- Colour composite (4R/5G/6B) on the Landsat 8 OLI +image from 2020.

Analysis of the status and dynamics of LULC

Spatial dynamics is based on an assessment of changes in states and a comparison of the area of different LULC units for the analysis of LULC dynamics, the rate of stability, regression or progression of thematic units is first calculated from one year to the next. This calculation was based on the deforestation rate formula used by Tabopda[27] and Koné[12], to determine the change between two study periods.

The variable considered here is surface area (S). Thus, S1 and S2, correspond respectively to the area of the class at date t1 and t2 (t2 > t1). The rates of change in area (TE) and the annual rates of change (TEA) were calculated using the following formulae:

$TE= [(S2 – S1) / S1 \times 100]$……………………………………………...(2)

$TEA = [(S2 / S1)^{1/t} – 1] \times 100$……….……………………….………………(3)

If, S2 - S1 = negative, we conclude that the vegetation cover has decreased from year 1 to 2.

- If, S2 - S1 = positive, indicating an increase in plant cover from year 1 to 2.
- If, S2 - S1= zero, meaning that the vegetation cover from year 1 to 2 is stable.

And then, the transition or conversion matrix of LULC types between two dates (t1 and t2) was produced. This matrix shows the zones of stability on the diagonal and enables us to understand the redistributions between them as well as between the different LULC [28]. The latter represent the gains made by others in the form of contributions. The period 1986-2020 was used for this approach, and the analyses focused on the redistribution of natural formation and the contributions to cash crop and crop/fallow expansion.

Results:-

Land use and land cover dynamics

Land-cover and Land-use (LULC) maps from 2000 to 2020 were used to characterize changes in vegetation cover and human activities in the Maféré sub-prefecture.

Figure 4 shows how LULC changed in 1986. The areas of LULC in 1986 and their proportions in relation to the total area of the sub-prefecture are shown in Table I. Closed forests and swamps forest predominate, covering 78,367.95 ha and approximately 53.01% of the total area of the Maféré sub-prefecture. Crops and fallow land occupy 37804.14 ha, or 25.57%, and oil palm occupies 1469.35 ha, or 12.49%. Degraded forest and cocoa represent 9,463.14 ha or 6.40% and 5,584.5 ha or 3.77% respectively. Dwellings and bare soil represent 4194.9 ha or 2.84% and water 3411.81 or 2.30%.

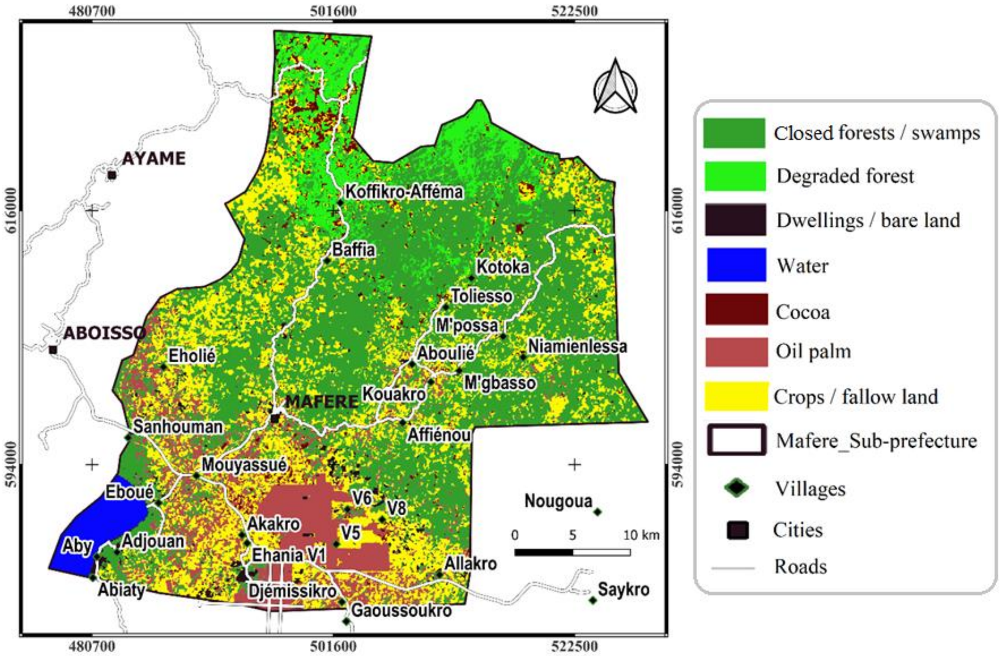

Figure 4: LULC map of the Maféré sub-prefecture (TM 1986)

Figure 5 shows the Land use and Land cover map of the Maféré sub-prefecture in 2000.

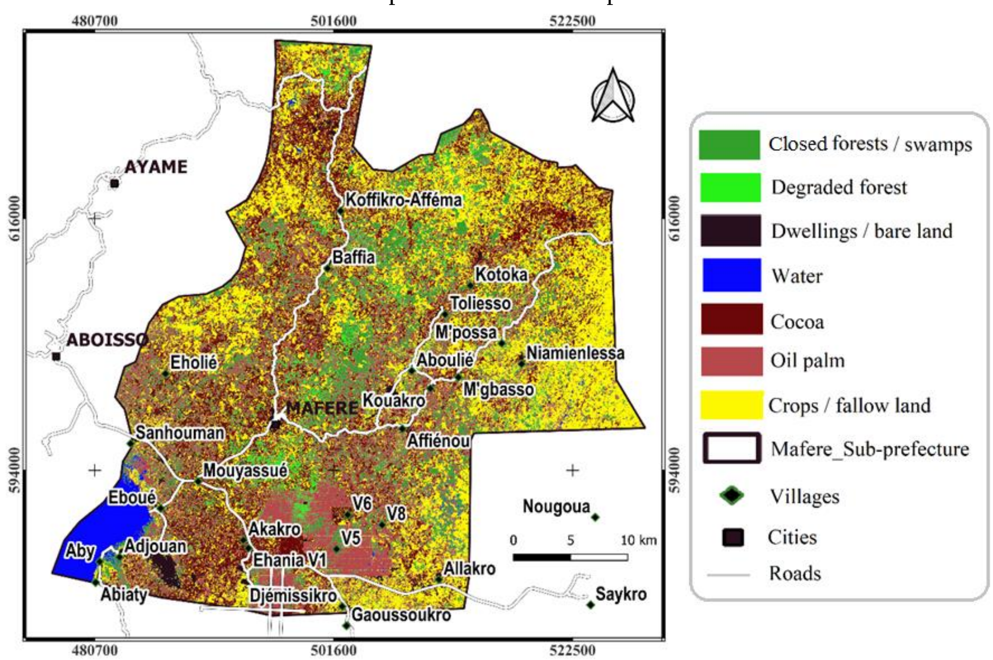

Figure 5: LULC map of the Maféré sub-prefecture (ETM+ 2000)

Table I shows the areas and proportions of LULC types in 2000. It shows that crops and fallow land and cocoa are the dominant plant formations, accounting for 44412.39 ha (30.04%) and 40510.26 ha (27.40%) of the total area of the Maféré sub-prefecture. Oil palm and closed forests and swampy forests occupy 30840.21 ha or 20.86% and 17972.37 ha or 12.05% respectively. Dwellings and bare soil cover an area of 5,377.14 ha, or 3.64%, and degraded forest 4,507.56 ha, or 3.04%. Water reservoirs represent 4212.72 ha or 2.85%.

The Land use and Land cover (LULC) map of the Maféré sub-prefecture in 2020 is shown in figure 6.

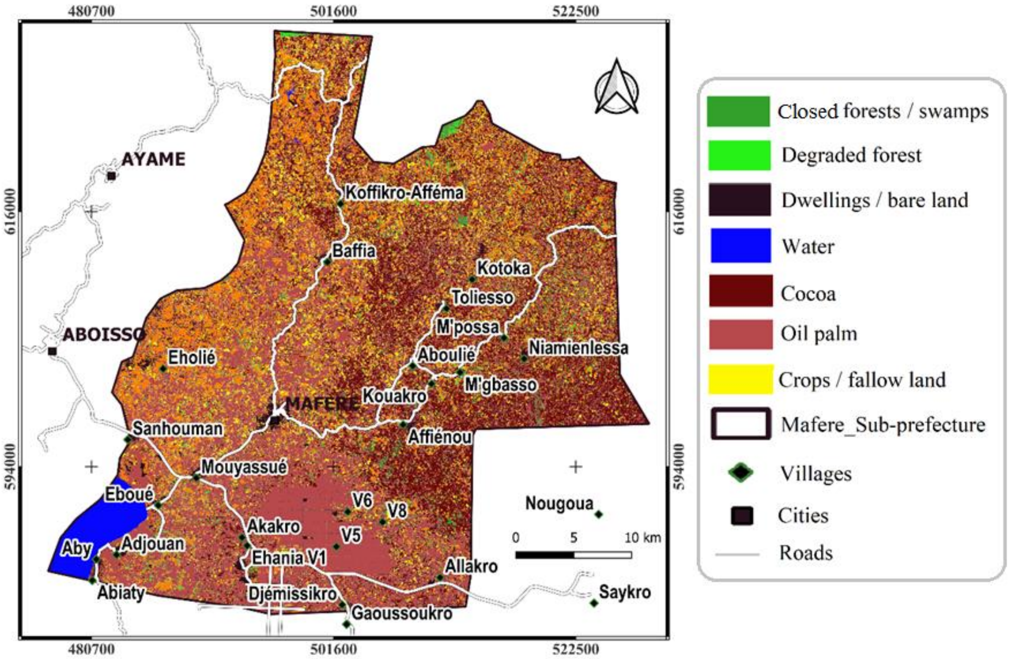

Figure 6: LULC map of the Maféré sub-prefecture (OLI+ 2020)

The areas and proportions of LULC in 2020 are shown in Table 1. Analysis of figure 6 shows that LULC is dominated by oil palm and cocoa, with areas estimated at 54139.68 ha (36.62%) and 43294.05 ha (29.29%) respectively. These are followed respectively by rubber trees (21276.81 ha or 14.39%), crops and fallow land (12465.18 ha, 8.43%) and dwellings and bare ground (8442.45 ha, 5.71%). Closed forest and swamps forests, which are only slightly present in the study area, cover a surface area of 2555.01 ha (1.72%) and degraded forest a surface area of 2199.96 ha (1.48%). Water reservoirs cover 3459.51 ha (2.34%).

Table 1: Areas and proportions of LULC in 1986, 2000 and 2020.

	1986		2000		2020	
	Area (ha)	**Prop (%)**	**Area (ha)**	**Prop (%)**	**Area (ha)**	**Prop (%)**
Fd_Fm	68904,81	46,61	17972,37	12,16	2555,01	1,73
Fdg	9463,14	6,40	4507,56	3,05	2199,96	1,49
Cr_Fal	37804,14	25,57	44412,39	30,04	12465,18	8,43
Dwe_Bar	4194,9	2,84	5377,14	3,64	8442,45	5,71
Water	3411,81	2,31	4212,72	2,85	3459,51	2,34
Coc	5584,5	3,78	40510,26	27,4	43294,05	29,29
Palm	18469,35	12,49	30840,21	20,86	54139,68	36,62
Rub	----	---	----	---	21276,81	14,39
Total Area	147832,65	100	147832,65	100	147832,7	100

Fd_Fm : Closed forests / swamps forests; **Fdg**: Degraded forest**; Cr_Fal** : Crops / fallow land; **Dwe_Bar** : Dwellings / bare land; **Coc** : Cocoa; **Palm** : Oil palm**; Rub** : Rubber trees.

Land use and land cover between 1986 and 2000

Changes in the area of LULC units between 1986 and 2000 (Figures 4 and 5) are shown in Table 2.

Table 2: Evolution of LULC between 1986 and 2000

LULC	**Area (ha)**	**TE (%)**	**TEA (%**
Fd_Fm	-50932,44	-73,92	-9,15
Fdg	-4955,58	-52,37	-5,16
Cr_Fal	6608,25	17,48	1,16

Dwe_Bar	1182,24	28,18	1,79
Water	800,91	23,47	1,52
Coc	34925,76	625,41	15,2
Palm	12370,86	66,98	3,73
Rub	-	-	-

Fd_Fm : Closed forests / swamps forests; **Fdg**: Degraded forest**; Cr_Fal** : Crops / fallow land; **Dwe_Bar** : Dwellings / bare land; **Coc** : Cocoa; **Palm** : Oil palm**; Rub** : Rubber trees.

A review of the 1986 and 2000 periods shows that closed forest/swamp forest and degraded forest have declined by 73.92% and 52.37% respectively, as they are the most heavily exploited. Cocoa crops and oil palms increased by 625.41% and 66.98% respectively. Over the same period, the area under crops and fallow land increased by 17.48% due to the clearing of natural vegetation for agricultural purposes. Dwellings and bare land also increased by 28.18%.

Evolution of LULC between 2000 and 2020

Table 3 presents a statistical summary of LULC between 2000 and 2020 (Figures 5 and 6) in the Maféré sub-prefecture.

Table 3: Evolution of LULC between 1986 and 2020

LULC	Area (ha)	TE (%)	TEA (%
Fd_Fm	-15417,36	-85,78	-9,29
Fdg	-2307,6	-51,19	-3,52
Cr_Fal	-31947,21	-71,93	-6,16
Dwe_Bar	3065,31	57,01	2,28
Water	-753,21	-17,88	-0,98
Coc	2783,79	6,87	0,33
Palm	23299,47	75,55	2,85
Rub	21276,81	14,39	

Fd_Fm : Closed forests / swamps forests; **Fdg**: Degraded forest**; Cr_Fal** : Crops / fallow land; **Dwe_Bar** : Dwellings / bare land; **Coc** : Cocoa; **Palm** : Oil palm**; Rub** : Rubber trees.

A review of the 2000 and 2020 period shows that closed forest/swamp forest and degraded forest have declined by 85.78% and 51.19% respectively. Cash crops (cocoa, oil palm and rubber trees) have increased by 6.87%, 75.55% and 14.39% respectively, due to poor management of plant formations. Agricultural activities in the area are the main cause of the degradation of plant cover. Vegetation formations are disappearing at an alarming rate due to the impact of climate change and variability. Crops/ fallow land and Water reservoirs are also declining (89.81%), to the benefit of Dwellings and bare land (57.01%).

Dynamics of LULC between 1986 and 2020

Table 4 summarizes land use and land cover (Figures 4 and 6) between 1986 and 2020.

Table 4: Evolution of LULC between 1986 and 2020

LULC	Area (ha)	TE (%)	TEA(%
Fd_Fm	-66349,8	-96,29	-9,24
Fdg	-7263,18	-76,75	-4,2
Cr_Fal	-25338,96	-67,03	-3,21
Dwe_Bar	4247,55	101,26	2,08
Water	47,7	1,4	0,04
Coc	37709,55	675,25	6,21
Palm	35670,33	193,13	3,21
Rub	21276,81	14,39	

Fd_Fm : Closed forests / swamps forests; **Fdg**: Degraded forest**; Cr_Fal** : Crops / fallow land; **Dwe_Bar** : Dwellings / bare land; **Coc** : Cocoa; **Palm** : Oil palm**; Rub** : Rubber trees.

Over the period from 1986 to 2020, the areas of closed forest/swamp, degraded forest and Crops / fallow land have declined considerably. This loss is equivalent to a regression rate of 96.29%, 76.75% and 67.03% respectively, to the benefit of cocoa, oil palm, rubber trees, Dwellings and bare land and water areas. On the other hand, the areas under cocoa, oil palm, rubber trees, Dwellings and bare land and water have increased. This corresponds to growth rates of 675.25%, 193.13%, 14.39%, 101.26% and 1.40% respectively.

Transition of LULC between 1986 and 2020

LULC types have been grouped together for a more objective analysis. These are the classes of Closed Forest/Swampy Forest; Degraded Forest; Crops/Fallow Land; Oil Palm; Cocoa + rubber; Housing/Bare Land and Water Bodies. The Cocoa class is very confused with the rubber class, which made it necessary to merge them in the transition matrix. The results of the spatio-temporal evolution of LULC in the Maféré sub-prefecture from 1986-2000, 2000-2020 and 1986-2020 are illustrated by the transition matrices (Tables 5, 6 and 7).

From 1986 to 2000, LULC underwent reconversion (Table 5). This analysis shows that closed forest/swamp forest has been converted to cocoa + rubber (31.63%), oil palm (22.12%) and crop/fallow (29.97%). Most of the degraded forests were also converted to cocoa + rubber (39.04%), oil palm (16.25%) and crop/fallow (31.71%). In total, we can conclude that 85.36% of the Forest class has undergone changes in favour of cash crops and Crop/Fallow. During the same period, the Cocoa + Rubber and Oil Palm classes remained unchanged at 37.06% and 25.28% respectively. In the case of Cocoa + Rubber, there was a strong conversion to Crop/Fallow (35.83%) and Oil Palm (12.83%). Oil palms were converted to Cocoa + Rubber (32.11%) and Crop/Fallow (23.83%). Dwellings/bare land were also replaced by various LULC types such as Cocoa + Rubber (27.76%), Oil Palm (18.53%) and Crop/Fallow (32.86%). This has led to a rapid change in LULC and contributed to a remarkable increase in forest cover. Finally, there has been a significant conversion of crop/fallow land to cocoa + rubber (39.62%) and oil palm (19.35%). The conversion of water surface areas was less significant.

Between 2000 and 2020, there were significant changes in the area of LULC types (Table 6). Closed forest /Swamp Forest were converted to Cocoa + Rubber (48.15%) and Oil Palm (32.79%). Degraded forests were also converted to cocoa + rubber and oil palm, at rates of 32.08% and 53.14% respectively. We can therefore conclude that 83.08% of the total forest area has been converted to cocoa + rubber and oil palm. In the case of oil palm, 41.77% was converted to Cocoa + Rubber. During this period, this habitat retained 43.47% of its initial area. During the same period, the Cocoa + Rubber class retained 41.67% of its total area. In addition, 38.11% of their surface area was converted to oil palm. The area of the Crop/Fallow class was converted to Cocoa + Rubber (57.13%) and to Oil Palm (26.59%). Dwellings/soils were converted to cocoa + rubber (21.03%) and oil palm (35.25%). Water bodies have retained 76.72% of their original surface area.

During the period 1986 to 2020, several changes were recorded (Table 7). Closed forest /Swamp Forest was heavily transformed into Cocoa + Rubber (61.76%) and Oil Palm (21.28%). The Degraded Forest class was heavily converted to Cocoa + Rubber (71.59%) and Crop/Fallow (18.7%). In the light of these findings, we can conclude that 86.66% of the Forest class was converted to cash crop and crop/fallow. This period was also marked by the maintenance of a high proportion of Cocoa + Rubber (56.85%) and Oil Palm (66.7%). However, 33.78% of the Cocoa + Rubber class was converted to Oil Palm and Crop/Fallow. Oil palms were converted to Cocoa + Rubber (18.18%). In terms of crop/fallow land, 85.18% of the area was converted to cash crops, i.e. 46.49% to cocoa + rubber and 38.69% to oil palm. In addition, 54.73% of dwellings/bare land were converted to cash crops. Finally, the surface area of water bodies was the most conserved over the period. There was only a 15.08% change.

Table 5: LULC transition matrix from 1986 to 2000

		2000							
		Fd_Fm	Fdg	Coc + Rub	Palm	Cr_Fal	Dwe_Bar	Water	Total
1986	Fd_Fm	8,35	3,08	31,63	22,12	29,97	3,75	1,1	100
	Fdg	5,44	2,81	39,04	16,25	31,71	4,54	0,2	100
	Coc + Rub	3,46	2,87	37,06	12,83	35,83	6,83	1,13	100
	Palm	9,21	4,22	32,11	25,28	23,83	4,92	0,44	100
	Cr_Fal	5,82	2,87	39,62	19,35	26,39	5,7	0,25	100
	Dwe_Bar	6,84	1,82	27,76	18,53	32,86	9,85	2,35	100
	Water	3,28	0,03	0,69	1,05	4,93	5,21	84,8	100

Fd_Fm : Closed forests / swamps forests; **Fdg** : Degraded forest; **Coc + Rub** : Cocoa and Rubber trees; **Palm** : Oil palm; **Cr_Fal** : Crops / fallow land; **Dwe_Bar** : Dwellings / bare land.

Table 6: LULC transition matrix from 2000 to 2020

		2020							
		Fd_Fm	Fdg	Coc + Rub	Palm	Cr_Fal	Dwe_Bar	Water	Total
2000	Fd_Fm	6,48	3,52	48,15	32,79	6,42	2,62	0,01	100
	Fdg	1,15	2,34	32,08	53,14	10,08	1,21	0	100
	Coc + Rub	0,28	1,2	41,67	38,11	13,18	5,55	0	100
	Palm	2,7	1,89	41,77	43,47	6,92	3,25	0	100
	Cr_Fal	2,07	1,58	57,13	26,59	7,43	5,2	0	100
	Dwe_Bar	0	0,79	21,03	35,25	6,87	35,96	0,09	100
	Water	0,95	0	3,35	17,6	0	1,38	76,72	100

Fd_Fm : Closed forests / swamps forests; **Fdg** : Degraded forest; **Coc + Rub** : Cocoa and Rubber trees; **Palm** : Oil palm; **Cr_Fal** : Crops / fallow land; **Dwe_Bar** : Dwellings / bare land.

Table 7: LULC transition matrix from 1986 to 2020

		2020							
		Fd_Fm	Fdg	Coc + Rub	Palm	Cr_Fal	Dwe_Bar	Eau	Total
1986	Fd_Fm	4,78	3	61,76	21,28	7,86	1,32	0	100
	Fdg	2,39	3,16	71,59	3,04	18,7	1,13	0	100
	Coc + Rub	0,27	0,63	56,85	16,75	17,3	7,91	0,29	100
	Palm	1,15	1,79	18,18	66,70	7,2	4,98	0	100
	Cr_Fal	1,05	1,61	46,49	38,69	7,18	4,98	0	100
	Dwe_Bar	1,12	1,02	22,38	31,93	4,21	39,11	0,24	100
	Water	0	0	0	8,11	3,05	3,93	84,91	100

Fd_Fm : Closed forests / swamps forests; **Fdg** : Degraded forest; **Coc + Rub** : Cocoa and Rubber trees; **Palm** : Oil palm; **Cr_Fal** : Crops / fallow land; **Dwe_Bar** : Dwellings / bare land.

Discussion:-

The results of this study show an increase in cultivated areas and a decrease in natural plant formations. In 1986, the surface area of forests (closed forest / swampy forest, degraded forest) was 78,367.95 ha, i.e. 53.01% of the total surface area of the Maféré sub-prefecture. At the same date, cash crops covered 24053.85 ha (16.27%). In 2020 (34 years later), the area of forest has decreased considerably. The current forest area is 4754.97 ha, or 3.22%, while the area under cash crops has increased from 16.27% to 65.91%. As a result, more than half of the forest area in the

Maféré sub-prefecture has disappeared. This reflects strong pressure on the forests in the study area. This loss of forest could be due to a rapid increase in cultivated land. This increase may be due to the population's frantic race against poverty, but also to the Ivorian state's economic policy, which is focused on export agriculture. According to UTCAF [29], the forest has been cleared to increase the area under export crops. In their study, Koné[12] and N'Guessan [30] also came to the conclusion that the areas used to plant crops are increasing considerably, to the detriment of natural plant formations.

With regard to the analysis of changes in LULC in the Maféré sub-prefecture, the results show the various transformations that have taken place over time. One of the most important conversions is mentioned by the Forest and Crops/Fallow Land class during the study period. During this period, forest and crop/fallow land were converted to cash crops. This transformation suggests a decline in natural vegetation. This finding was highlighted by Freud et al. [31], who state that 89% of crops in Côte d'Ivoire are grown on primary and secondary forest clearings. Several authors ([32], [25]) have also made the same observation: their results revealed that natural plant formations made up of closed forests, degraded forests and secondary forests have mainly been converted to crops and fallow land.

The decline in forest and crop/fallow areas is due to human activities, but also to population growth. Rapid population growth is leading to an increase in food and housing requirements. This observation is in line with the work of Ba et al. [33], who stated that in the sub-Saharan region, population growth and the land crisis are encouraging people to deforest protected areas. This decline in natural plant formations is accompanied by a loss of biodiversity and land degradation.

This loss is also due to agricultural practices, firewood production and artisanal logging, as the study area is in fact predominantly used for perennial crops such as oil palm, rubber and cocoa. It is also an area where food crops such as cassava are grown, hence the advanced degradation of the forest formations. The reduction in forest cover can also be explained by the type of agriculture practiced by local people. Such observations were reported by Kouassi [34], who states that after one or two years of food crops, farmers abandon the plots under cultivation to colonize new, more fertile forest land, leaving the former fallow in order to restore their fertility.

Conclusion:-

This study began by characterizing LULC in the Maféré sub-prefecture for the three years of observation (1986, 2000 and 2020), and then analyzed the dynamics of vegetation cover degradation in the study area. All these operations made it possible to assess the surface area of each type of LULC, its location and the changes that occurred in LULC during each period. In addition, the analysis of LULC showed a significant decline in natural plant formations (closed forest/swamp, degraded forest) and an increase in developed areas (cash crops and housing/bare land). Vegetation formations have decreased from 78367.95 ha in 1986 to 4754.97 ha in 2020, i.e. a decline of 173.04%, while human activities have increased their surface area from 28248.75 ha in 1986 to 105876.18 ha in 2020, i.e. 969.64%. This decline in plant formations is particularly critical. Closed/Swamp Forest and Degraded Forest are being destroyed in order to obtain arable land for the development of cocoa, rubber and oil palm cultivation in particular.

Conflict of Interest:-

None declared.

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